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A
POCKET MANUAL
OF
PERCUSSION AND AUSCULTATION
FOR
PHYSICIANS AND STUDENTS.

TRANSLATED FROM THE SECOND GERMAN EDITION

By J. O. HIRSCHFELDER.

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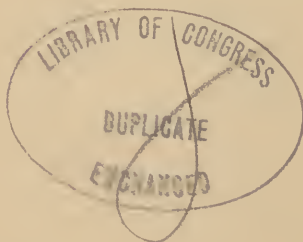
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TRANSLATOR'S PREFACE.

HOWEVER numerous the works that have been previously published in the English language on the subject of Percussion and Auscultation, there has ever existed a lack of a complete yet concise manual, suitable for the *pocket*.

The translation of this work, which is extensively used in the Universities of Germany, is intended to supply this want, and it is hoped will prove a valuable companion to the careful student and practitioner.

J. O. H.

SAN FRANCISCO, }
November, 1872. }

PERCUSSION.



FOR the practice of percussion we employ a pleximeter, or a finger, upon which we strike with a hammer, or a finger, producing a sound, the character of which varies according to the condition of the organs lying underneath the spot percussed.

In order to determine the extent of the sound produced, we may imagine the following lines to be drawn upon the chest: (1) the mammary line, which begins at the union of the inner and middle third of the clavicle, and extends downwards through the nipple; (2) the parasternal line, which extends midway between the sternum and nipple; (3) the axillary line, which extends from the centre of the axilla to the end of the 11th rib. Upon the back we percuss in a line running parallel with the spinal column, and according to the various regions, *regio supra spinata*, *scapularis* and *infra scapularis*. For the percussion of the abdomen, the *linea alba* and the known anatomical regions, are taken into consideration.

Percussion Sounds.

[By the percussion of a portion of the surface of the body, we obtain either a dull sound, or one varying in its intensity, pitch, duration and timbre.]

DULL SOUND.

This always arises from the blow alone, whenever the subjacent organ does not possess sufficient elasticity to produce audible vibrations, and the percussion impulse is not transmitted through it to more elastic parts. The necessary vibratory power is lacking in all parts not containing air, and in all fluids. The dull sound therefore shows that there is underneath the percussed spot, liver, heart, spleen, new formation not containing air, uterus, distended bladder, stomach filled with fluid, hepatized lung, (or one emptied of its air by compression,) or bloody, purulent, or serous fluid. The nature of these parts cannot be distinguished through percussion, be they constituted in any way whatever, hard or soft, free or enclosed. But where, on the other hand, the above parts border upon organs containing air, which give no dull sound, we can specify their extent with great accuracy.

SONOROUS SOUND.

The sonorous sound is produced whenever

sufficiently elastic parts receive the percussion impulse. Such elastic parts are tense membranes, and air or gas, the latter when in enclosed cavities so that permanent waves are formed.

The sonorous sound shows, since the membrane can be made tense only through air or gas, that one of these exists under the percussed spot.

The sonorous sound is either tympanitic or non-tympanitic. We call a sound tympanitic when it approaches a musical note and shows a musically determinable pitch; when in other words it is not a mere noise but a real tone.

TYMPANITIC SOUND.

This always occurs whenever the formation of uniform and regular permanent sound waves is possible.

All the sonorous cavities in the thorax and abdomen are limited, and consequently allow the formation of permanent waves.

Regular wave systems are possible in the thorax and abdomen, however, under the given conditions only, when the sound is produced by the air alone. This takes place when the air is enclosed by walls which are not sufficiently tense to be capable of audible vibrations, but which

can merely reflect them. As soon as they become so tense, that they can also produce audible vibrations, the sound waves become irregular through the spherical tension of the walls enclosing the air, and the percussion sound becomes non-tympanitic, or a mere noise.

The tympanitic sound therefore shows, that under the percussed spot air spaces exist with walls not sufficiently tense; such are:

1. Either normal or pathological cavities, completely or partially filled with air, whose walls are not too strongly stretched: such are the stomach, intestine, cavities, Pneumothorax, Tympanites Peritonialis.

2. A portion of lung, whose cells and bronchial walls have lost their normal tension through loss of their elasticity and contractility (power of retraction), or through compression to a smaller volume, so that the power of retraction can be no longer exercised.

NON-TYMPANITIC SOUND.

This always occurs whenever audible vibration of air-enclosing walls, such as lung parenchyma, stomach, intestinal or chest walls, is possible. It therefore shows a certain amount of tension in the above mentioned parts.

We obtain tympanitic sounds:

(a) Under normal circumstances in the region of the stomach and intestinal tube, as long as these contain air or gas, and their walls and those of the abdomen are not too tense. The non-tympanitic sound of this region is therefore abnormal, and shows either an entire filling of the above organs with fluid, or a change produced in them by solid organs or fluids; or, finally, unusual tension of the walls, as in Meteorism.

(b) Under abnormal circumstances it is possible at every point of the thoracic or abdominal walls: 1, above free air in the thoracic or abdominal cavity in Pneumothorax or Tympanites Peritonialis; 2, above superficial air cavities and dilated bronchial tubes, when it is alterable in pitch by opening and closing the mouth; 3, over air-containing parts of the lung whose vesicles have lost their tension from acute exudation into them without compression of the air, as in acute Oedema, acute Miliary Tuberculosis and incipient Pneumonia. It may be produced by rapidly arising Emphysema (around infiltrations), sometimes also by chronic Emphysema, when it is equally spread over a large number of vesicles, or by compression of the entire lung, as above pleuritic exudations, Emphysema, or Hydrothorax.

Normal lung never sounds tympanitic, as long as its tissue is contractile. The stomach and intestines, Pneumothorax and Tympanites, no longer sound tympanitic when the former become so distended, or the latter so considerable that the thoracic, intestinal, or abdominal walls become tightly stretched.

The sonorous sound, most plainly the tympanitic but also the non-tympanitic, shows differences important for diagnosis:

(1.) According to the *size* of the vibrating mass of air, the sound is full and long, or empty and short.

Wherever parts of similar character, capable of vibration, take up a greater space, the sound waves produced being therefore longer, the blow gives a fuller, longer, deeper sound, if it is strong enough to spread the impulse sufficiently. The less the extent of the part, the higher and shorter is the percussion sound.

That the elasticity of the vibrating part influences the duration of the tone (its volume) is a matter of course.

Healthy lung, Pneumothorax, and distended stomach sound full. Generally emphysematous lungs sound fuller than normal; intestines and cavities in tissue not containing air, shorter.

Small superficial cavities and thin layers of lung not containing air, as the lower border of the right lung and the inner of the left, sound very short and empty. The stomach and duodenum sound tympanitically full, and the small intestines tympanitically short. Incipient Pneumonia, acute Œdema of an entire lung, sound tympanitically full; and partial Emphysema around a hepatized part of the lung, tympanitically short.

With the tympanitic sound all these differences are recognized as variations of the musical pitch of the tone. Yet the size of the vibrating part cannot always be determined by the absolute degree of the fullness or shortness of a percussion sound, as comparison with other spots is alone of value.

(2.) According to the *nature, thickness, resistance and conductivity* of the medium conducting the percussion impulse, the sound is either clear or dull.

Wherever a thicker layer of medium, which does not sound, lies between the percussion stroke and the mass of air set into vibration, and the impulse (as well as the vibrations produced) is badly conducted, the percussion sound produced becomes duller. Air spaces immedi-

ately behind an elastic chest-wall, which is not too fleshy, or behind the epigastrium, alone sound fully clear.

The muffler* of a percussion sound may be situated in the percussed medium, or in the chest or abdominal wall itself. The conductivity may be interfered with by adjacent non-elastic parts, or non-sounding mediums may have been interposed between the thoracic or abdominal walls and the sonorous space. The sound may be muffled by those parts of the subjacent organs, immediately beneath the point of impulse, becoming empty of air which they normally contain.

A thick pleximeter, strong ribs or ossification of their cartilages, or greater convexity than common, fleshy thoracic or abdominal walls, tension of the muscles, Œlema and other swellings, and solid organs or fluids lying against them, muffle the sound of the lung and the abdominal organs containing air. The borders of the liver muffle the sound of the stomach and colon lying behind them. Great thickening of the pleura after Pleuritis, and exudations into the pleural sac, as long

*The muffler is that which deadens the percussion sound. Its activity is in inverse proportion to the strength of the blow.

as they do not exclude all the air, deaden the lung sound. In a similar manner inflammatory or dropsical transudations into the peritoneum deaden the intestinal sound. Great thickening of the walls of the stomach and intestines has the same effect. Superficial hepatization of the lung operates similarly, while the same changes in parts situated more deeply merely shorten, not deaden, the percussion sound.

There are many changes of the lungs which lessen the elasticity, the conduction of the impulse, and the vibrations at the same time. In these cases the sound becomes simultaneously shorter, weaker and duller.

Chronic Œdema of the lung and Tubercular Infiltration, with small cavities which do not communicate, shorten and deaden the sound.

(3.) *Peculiar modifications* of the sound are the following:

(a) The *metallic* percussion sound (*son hydro-pneumatique*—*Piorry*). This exists only over large air spaces, whenever the sound waves are regularly reflected from two points of the surrounding wall, so that through interference independent sounds are formed. This takes place whether the space gives a tympanitic sound or not, *i. e.* whether the walls are tense or not. It occurs

only over a stomach containing air, or over very large cavities, or in Pneumothorax.

(b) *Cracked metal sound* (*Bruit de pot fêlé*). This may be imitated by percussion upon the hand placed over the ear. It occurs over a large superficial cavity communicating with a bronchus, or over a dilated bronchial tube, and arises from the fact that by a strong blow the cavity becomes somewhat compressed and the contained air empties into the bronchus, producing a whizzing noise, and this mingles with the ordinary short and tympanitic sound of the cavity.

Opening the mouth usually assists in producing this phenomenon. A very strong stroke in percussing, especially in the infantile thorax, produces, by its compression, an analogous wheezing occasioned by the forcible expulsion of air. This may also be obtained from healthy lungs.

In complete compression of one lung by fluid pleuritic exudations we sometimes hear a very short metallic, ringing, cracked-pot sound (sound of rattling coin) in the region of the large bronchi upon strong and short percussion.

The hydatid tone of Piorry, represented by him as being perfectly characteristic of Echinococcus-sacs, is probably only a feeling of fluctuation in percussing.

Percussion of the Organs.

By means of the distinction between the dull and sonorous sounds we can determine the normal area of the organs of the chest and abdomen.

LUNGS.

The area of the lungs in the average man is as follows:

The apices of the lungs are percussed in the supraclavicular fossa close to the origin of the Sterno-cleido-mastoideus.

The right lung extends downwards in the parasternal line to the union of the sternum with the ensiform process, in the mammary line to the upper border of the 6th rib, in the axillary line to the upper border of the 8th rib, and behind, at the spinal column, to the eleventh rib. In the median line it extends toward the left almost to the border of the sternum, where the border of the right lung together with that of the left, passes downwards to the fourth intercostal space, and then obliquely toward the right to the above-mentioned point in the parasternal line.

HEART.

The size of the heart is determined through the dull percussion sound which is given by

that portion immediately in contact with the chest and not covered with lung tissue, forming the so called *cardiac vacuum*. Some observers seek to determine its size by the "*cardiac dullness*," which is heard at those places where the borders of the lung cover the heart.

The cardiac dullness, determinable through strong and deep percussion, forms upon the chest-wall a triangular figure with blunt apex and somewhat convex sides.

The upper angle lies at the union of the 3d left costal cartilage with the sternum. The right angle lies over the sixth rib, 4c.m.* from the median line. The left angle lies in the 5th left intercostal space, where the apex beat is visible, 10 to 11c.m. from the median line.

The so-called *Cardiac Vacuum*, (*Herzleerheit*) is found only upon weak, superficial percussion, and is also described by a triangle, whose base corresponds with that of the larger one, whose apex lies at the fourth intercostal space, at the left border of the sternum, whose right angle lies in the median line at the upper end of the ensiform process, and whose left angle generally falls upon the apex beat, midway between the man-

*A centimetre = .3937 inch.

mary line and the left sternal border, but sometimes a little more to the left.

Increased cardiac dullness occurs: (1) in Hypertrophy and Dilatation of the heart; (2) in Pericardial exudations and tumors; (3) when the heart is forced forward from behind by exudations etc., so that a greater surface lies in contact with the chest wall; and (4) when the adjacent parts of the lung give a dull sound, as in pleuritic exudations, mediastinal tumors and aneurisms of the aorta. Diminished cardiac dullness occurs when the border of the lungs extends over the anterior cardiac area. The lungs may then be either normal or emphysematous.

LIVER.

The dimensions of the liver must always be measured in cases of accidental changes of its position. We find that the upper part of the liver is covered by the descent of the lower border of the right lung into the space between the rib walls and the diaphragm, which rises obliquely upwards and inwards. In consequence of this, a layer of lung tissue, which gradually diminishes in thickness from above downwards, lies between it and the chest wall. The other parts of the liver lie in contact with the chest

wall. The highest point of the convex surface of the liver reaches about to the altitude of the 4th rib. The lower border lies concealed in the right hypogastrium under the vault of the ribs as far as to the tenth. From this point it can be followed obliquely through the epigastrium midway between the navel and the ensiform cartilage towards the left hypogastrium. Percussion, which should be very strong for the upper part as far as it is covered by lung, but weak for the lower part, gives the length of the area of liver dullness:

In the mammary line = 11 to 13 c. m.

“ axillary “ = 12 c. m.

“ parasternal “ = 10 c. m. .

The dullness of the left lobe extends sidewise from 7 to 8 c. m. beyond the linea alba.

• SPLEEN.

The spleen lies in the left part of the abdomen and runs forward, outward, and downward, nearly parallel with the tenth rib, and under the 9th intercostal space. In practice the determination of its anterior angle and of its breadth in the linea axillaris is usually sufficient.

Percussion in the axillary line gives the extent of the spleen under the ninth or tenth rib = 5

c. m. The dullness is bounded inferiorly by the anterior end of the eleventh rib, superiorly by the ninth rib opposite the axilla, posteriorly by the eleventh dorsal vertebra, and anteriorly by an imaginary line drawn from the end of the eleventh rib to the nipple. If the spleen is not found in the latter line it is not enlarged, as a normal spleen never extends thus far. The spleen is examined principally by palpation.

Variations of the extent and position of the above organs are likewise determined by means of the distinction between the dull and the sonorous sound, provided no two solid parts border upon each other, or the air capacity of the abdomen is not affected by new formations or fluids, or the lung has not become empty of air by pathological processes, or pushed aside by pleuritic exudations.

PALPATORY PERCUSSION.

Percussion has a further importance as regards knowledge of the nature of the percussed organs, from the fact that we can take the feeling of resistance into account at the same time. We practice palpatory percussion simultaneously with acoustic percussion, as mediate, or better alone as immediate percussion, employing one finger bent in the form of a hook.

The resistance appreciable in percussion depends upon the nature of the medium conveying the impulse. The thicker and more unyielding and inelastic the medium, the more appreciable does the resistance become.

The abdominal and thoracic walls of children give almost no resistance, which depends alone upon the subjacent organs. Infiltrated or hepatised lungs increase the resistance of the thorax; fluids within the cavity of the chest, which make the thoracic walls tense at the same time, give the greatest resistance.

PECTORAL OR VOCAL FREMITUS.

In the normal condition of the respiratory organs, the hand placed directly upon the thorax of a person speaking in an ordinary tone of voice feels trembling movements accompanying those of the chest; this fremitus is as a rule stronger on the right than on the left side. It arises through the conduction of the vibrations, produced in speaking, to a thoracic wall capable of vibration. The better the conduction and the less tense the wall, the stronger is the vocal fremitus; the worse the conduction and the more tense the chest wall, the weaker it will be.

The tension of the wall is diminished wher-

ever the power of retraction of the lung becomes extinct, therefore where tympanitic sound exists. It is increased wherever firm or fluid bodies touch the wall, that is where resistance against percussion diminishes, and also where it becomes greatly distended with air, as in Pneumothorax which no longer sounds tympanitic.

Since infiltration of the parenchyma always diminishes its power of contraction, both of these conditions must balance; or, according to the magnitude of the infiltration, the incipient relaxation of the thoracic wall, attended with increase of the vocal fremitus, must gradually pass into a diminution of its power of vibration, with cessation of fremitus.

Fremitus is considerably increased over large cavities with rigid walls lying closely against the thoracic walls.

It is always absent in pleuritic exudations, and is always increased whenever tympanitic sound is heard in the beginning of Pneumonia, and around lung tissue so affected, and also over pleuritic effusions. It is usually strengthened over hepatizations, as long as they do not become so thick as to interfere with the vibratory power of the chest wall. In such a case the vocal fremitus also disappears. As long, however, as

this condition does not arise, the presence of a distinct fremitus with intense dullness allows inflammation of the parenchyma of the lung to be inferred, rather than pleuritis.

When fremitus is weakened on the right side, it has far more importance than when it takes place on the left, where it is normally weaker.

AUSCULTATION.

We practice auscultation by listening, either immediately with the ear, or mediately with a stethoscope, to the noises or tones arising in the respiratory and circulatory organs in the performance of their functions, that we may judge thereby of their anatomical conditions.

Auscultation is founded upon the fact that in anatomical and physical changes of affected organs, the acoustic properties also assume other forms.

Auscultation of Respiratory Organs.

We divide sounds perceived in these organs into:

(1) True respiratory murmurs which arise only through the air, in its passage in and out, coming in contact with the firmer parts of the respiratory organs; and

(2) Râles, which arise from the air meeting with fluids while passing in and out through the air passages.

TRUE RESPIRATORY MURMURS.

(a) *Vesicular Respiratory Murmur.*—This is similar to the sound produced by the lips in

drawing in the air. It is audible almost only in respiration, and is never heard in places other than those in which it originates. It arises through the friction of the air against the walls of the fine bronchi and lung cells, whose contractility it must overcome, and thus cause them to unfold.

It therefore shows that the air rushes into normally contractile vesicles of the part of the lung lying under the ear, and consequently excludes all diseases which relax the vesicles or make the entrance of air impossible.

Wherever vesicular murmur is heard the lung is necessarily healthy. It is the louder, the thinner the chest wall, as in children, the stronger the current of air, and the greater the resistance of the cells, or when other parts of the lung do not breathe—supplementary vesicular respiration. It is the weaker under the opposite conditions. The loud vesicular murmur is also called puerile. Its absence on the other hand never has positive meaning, as it is heard neither when the vesicles are emphysematously dilated and contain air, when they are infiltrated and do not contain air, nor when the bronchial tubes have become impassible.

A variety of vesicular respiration is connected

with lengthened expiratory murmur, and occurs in all conditions which diminish the volume of the bronchial tubes, as in the case of swelling of the mucous membrane, etc.

(b) *Bronchial Murmur*.—This is similar to the sound produced by inspiration and expiration with the tongue slightly elevated towards the palate, as in the pronunciation of the letter K. It is especially an expiratory murmur, and arises only in the larynx and trachea by the friction of the inspired and expired air against the firm walls of these parts. It is therefore always heard in the thorax in other parts than those in which it arises.

Bronchial murmur may consequently be confirmed by auscultation of the larynx and trachea. Whenever heard in the thorax, it shows that alterations of the lungs must have occurred which cause the laryngeal or tracheal respiration to be audible to the distant ear. These must be of such a nature as to interfere with the expansion, and consequent weakening of the original sound, which occurs in normal air-containing lungs, naturally bad conductors of sound.

We find the necessary conditions when an air-containing space, such as a bronchus or cavity, freely communicating with the larynx and tra-

chea (the point of origin), is surrounded by firm walls, which prevent the extension of sound, parenchyma, for instance, which has become empty of air. A communicating tube from the trachea to the ear auscultating upon the thorax is thus formed, and conducts the sounds produced at one end unweakened and without any disturbing conditions to the other. Through this the sound arising at the larynx or trachea, becomes distinctly audible at the thorax, and preserves its original sharp timbre.

Bronchial murmur therefore shows that a pervious bronchus, or an air-containing cavity, as above described, is situated at a short distance from the chest wall in tissue which is empty of air, either by being completely filled with firm or fluid exudations, or by being compressed from without.*

Observation.—Strong laryngeal or tracheal murmur, as in dyspnœa, is often heard on deep inspiration, even in lungs containing air, between the shoulder blades or sometimes under the clavicles, *i.e.* along the larger bronchial branches. It then occurs upon both sides and has its own peculiar, almost metallic timbre. The strong

*Bronchial respiration can therefore be confirmed by percussion.

bronchial murmur of hepatized lungs may sometimes be heard in healthy lungs, along the inner border of the shoulder blade.

In some cases a bronchial murmur differing from the tracheal sound in pitch, arises from the fact that the stagnated air of a bronchus, surrounded by firm walls, is put into sonorous vibrations (consonance), by a current of air passing by, as takes place in blowing over an open key.

Bronchial murmur is heard :—1, over inflammatory, tubercular or cancerous hepatizations, as strong bronchial respiration; 2, sometimes, but not often, over Œdema of a high grade, and Hæmorrhagic Infarctions; 3, in compression of the lung by Pneumothorax, Pyothorax and Hydrothorax, when the bronchi remain open, and then it exists as feeble bronchial respiration, which entirely disappears upon increase of the compression; 4, in cavities and dilated bronchi, when they are surrounded by thickened parenchyma, as in cases where there is considerable thickening of the bronchial walls.†

†In vesicular as in bronchial respiration, inspiration and expiration may follow in jerks (*respiration saccadee*); showing that in the entrance of the air into a part of the lungs obstructions occur, which are gradually overcome in the progress of inspiration.

(c) *Indefinite Respiratory Murmur.*—This is similar neither to the bronchial nor to the vesicular murmur, and is heard both upon inspiration and expiration. It arises through various causes and is sometimes heard at its point of origin, sometimes in distant places, and therefore shows no certain condition of the respiratory organs. It is not heard in entirely healthy lungs, and we therefore search whenever we find it, for other signs in order to form a conclusion concerning the condition of the lungs and bronchial tubes. Distant bronchial breathing, and distant râles lose their characteristic properties, and become indefinite; and the mingling of different sounds allows none to be definitely recognised. The indefinite respiratory murmur always shows an obstruction in the bronchi. The modification of the vesicular respiration which occurs with strengthened and lengthened expiratory murmur, is worthy of notice. It indicates an obstructive catarrh of the finer bronchi, and therefore occurs so often in the early stages of Tuberculosis.

(d) *The indefinite respiratory murmur* often becomes *rattling, whistling* or *hissing* when the air forces itself through narrowed places in the air passages, rattling in the wide, and whistling

in the narrow bronchi. This rattling, whistling or hissing (called dry râles,) shows nothing definite concerning the condition of the parenchyma of the lungs. It is heard during inspiration and expiration, and distant also from its point of origin. It is often spread over the whole thorax, and may be conducted, in the same manner as tracheal murmur, to very distant places under favorable conditions. The vibrations which occasion such sounds may often be felt by the hand. Palpation differentiates them from friction sounds through the fact that they are not limited like the latter.

Bronchitis, Catarrh and swelling of the mucous membrane produce these modifications of the indefinite murmur, and thereby only too often render it impossible to determine whether air enters the vesicles or not.

RÂLES.

These usually resemble the sounds made by the bursting of the bubbles of a fluid. Sometimes they resemble the creaking of leather, or the rumpling of paper. The former, which are called the moist, gradually shade into the latter. They show one difference, namely, that the air, inspired and expired in breathing, forces

itself through fluid in its passage. They are the dryer, the tougher the fluid through which the air forces itself, and the more numerous, the more fluid there is. Râles may be classified as follows:

(a) *Vesicular Râles*.—By these we know that the vesicles forced open are small and of uniform size. They may be heard during inspiration or expiration, or during both. Râles with very small bubbles can be formed only in the finest bronchi and in the air cells. Vesicular râles, therefore, arise when the air in these parts encounters fluids. They show that air still forces itself into the lung vesicles under the ear, and consequently, have in this respect the same meaning as vesicular murmur. But they show, furthermore, that these parts are filled with fluid.

We hear moist vesicular râles when the lung cells are œdematously infiltrated, and dry râles when they contain coagulable exudations, as in the first and last stages of Pneumonia, and recent Pulmonary Hæmorrhage.

(b) The *bronchial*, or so called *consonant râles* of Skoda. These are recognized by being loud, high, and ringing in character, not uniform in their bubbles, and accompanied by resonance.

Ringing Râles, whose bubbles are not uniform,

can occur only in large spaces partially filled with fluid, in which the air moves, as large bronchi and cavities. In the healthy thorax they can be heard only at a distance from their point of origin, and consequently sound only dull and deep. Whenever they are heard clear, high, and ringing in the thorax, they show, either that just underneath the chest there exists a cavity containing fluid into which air enters and from which it is expelled; or, that the changes which bronchial murmur indicates must have taken place. In this case the clear and high pitch râles, whose bubbles are not uniform, arising in the larger bronchi especially, must be conducted undiminished to the periphery. They therefore indicate the same conditions as the bronchial murmur, and also that fluids exist in the larger air passages at the same time.

Tubercular infiltrations, cavities, and hepatizations usually allow bronchial râles to be heard when fluids exist in the large bronchi. The more ringing and the drier the râles, the more probable is it that they arise in cavities. They therefore, with few exceptions, indicate advanced Tuberculosis.

(c) *Indefinite Râles*.—To this class belong

all râles which are not distinctly vesicular or bronchial. They appear dull, deep and dissimilar in the size of their bubbles, and without resonance. Since they arise from the most different conditions of the lungs, they indicate no definite alteration. They merely show the presence of fluids in general in the air passages.

With normal percussion they lead us to infer catarrhal affection of the bronchi.

Observation.—Very fine crepitant râles, constant only during inspiration, and similar to the sound produced by the rubbing together of dry hairs, are caused by the air forcing itself into the finest bronchi and lung vesicles, whose opposite walls are made adherent by a tough exudation. (Wintrich.) They indicate the primary stage of Pneumonia, but are also often heard in healthy lungs, after persons have been long in the recumbent posture and fully expand their lungs again for the first time by a deep inspiration.

Auscultation of the Voice.

In the auscultation of the voice we observe the following abnormalities:

1. *Simple Bronchophony.* (Weak bronchophony of Skoda.)—In this the vocal tones are

audible at the thorax as voice, but are not accompanied by any vibration of the inner ear. The voice, which is formed in the larynx alone, can be distinctly heard at the thorax as voice, only when the regular laryngeal vibrations can be completely conducted to the auscultated point of the periphery through an air tube. Bronchophony takes place, therefore, when the conditions of bronchial murmur are present.

It has the same meaning as bronchial respiration, serves to control its correct interpretation, generally arises earlier, and is usually also audible in compression of the lung by exudations.

(2) *Strong Bronchophony, Pectoriloquy.*—In this the voice sounds as if articulated immediately into the ear. It is accompanied by concussion of the ear and through this has tone. It arises when the conditions are especially favorable for the undiminished conduction of the voice, *i. e.* when the sound-conducting tubes either diminish regularly in size, or end in irregular cavities. In the first case through the continued condensation of the progressing sound waves, and in the second, through a similar operation of direct and reflected waves, an augmentation of the original sound can arise.

When strong bronchophony is heard over a large extent, an inflammatory hepatization has probably occurred. In tuberculous lungs the points where cavities are situated oftentimes cause distinct pectoriloquy.

(3) *Indistinct humming* or total absence of the voice arises in normal lungs, but also in any disease in which one of the conditions of bronchophony is absent. It therefore has no definite signification.

(4) *Egophony*.—The voice has a peculiar tremulous character. It has the same significance as bronchophony, with which it may be heard alternately at one and the same place.

Peculiar modifications of the phenomena of auscultation are:

Amphoric resonance and *metallic ringing* of the respiratory murmur, and râles as well as of the voice.

They may be imitated by speaking or blowing into a vessel. In this besides the original sound, an echoing hum, or even single, ringing, high pitched tones are perceived.

They arise whenever separately sounding vibrations and independent acoustic phenomena are produced in a large space containing air, with walls capable of reflecting sound by the en-

trance of the sonorous waves of bronchial respiration, râles or bronchophony.

They indicate either large cavities or Pneumothorax. Respiratory murmurs more frequently cause amphoric resonance, while râles and speaking produce metallic ringing. In order that these phenomena should occur in Pneumothorax a free communication with a bronchus is unnecessary. Sometimes only short, high sounds caused by single râles are heard with each inspiration and expiration. They were formerly incorrectly ascribed to the falling of drops.

Friction Sounds.—These usually resemble the sounds produced by rubbing the dry surfaces of the hand against each other, or that occasioned by the creaking of leather. In the latter case they very much resemble dry râles, but are as well felt as heard, which is not the case with râles. Friction sounds are usually audible during both inspiration and expiration.

They arise in roughening of the pleura or the pericardium, when the performance of the function of the lungs or heart occasions a movement of their opposite layers. With few exceptions, they indicate inflammations of the serous membranes within the thorax.

Recent Pleuritis and Pericarditis cause fric-

tion sounds as long as fluid exudations do not separate the serous layers from each other. In the cardiac sac a considerable quantity of fluid does not always hinder their occurrence. More frequently friction sounds occur in the pleura or pericardium after resorption, until union or smoothing has taken place.

Auscultation of the Circulatory Organs.

In all acoustic phenomena in the circulatory apparatus a vibratory body, (valves and tube walls,) and the force producing vibration, (the moving blood,) come into consideration. If the vibrations are regular a tone arises; if they become irregular or unequal through disturbance of one of the two factors, a murmur occurs. On the other hand, circumstances may arise which render processes appreciable to the ear, which normally are inaudible.

CARDIAC SOUNDS.

We hear two tones in the cardiac region during a ventricular systole and diastole, which indicate alternate conditions of the heart. The most probable theory of their origin is the following:

The first tone, accompanying the systole and

the cardiac impulse, lasts as long as the systole. It is produced in both ventricles by the concussion caused by the systolic pressure of the blood in the venous valves closed at the end of the contraction of the auricle, and stretched during its diastole. It is also produced in the arteries by the vibrations of their walls made tense by systole. These vibrations are synchronous with the pulse.


The second tone, accompanying the diastole, clearer, higher and shorter than the first, arises, on the other hand, only at the point of origin of the arteries. It is formed by the vibrations of the semi-lunar valves, because with the close of the systole, the arterial column, brought under greater pressure by the tension of the arteries, forces the valves against the ostium and sets them into sonorous vibrations. It is the louder the fuller the arteries, therefore the stronger the impulse producing the shock.

We obtain six cardiac tones in the following manner: The first sounds are double as well in the ventricle as in the vessels. The second sounds arise only in the vessels and are therefore conducted when they are heard in the region of the valves. (Bamberger.)

According to Skoda, two sounds occur in each

ventricle and blood-vessel, so that in all eight tones are formed.

Rapp, Kiwisch, and Nega accept only four tones, the first two arising in the ventricles, the last two in the vessels.

The accentuation (— ) falls upon the first sound in both ventricles; over the aorta and pulmonary artery, on the other hand, it falls upon the second sound.

When we hear tones at the heart it shows that the functions of the muscles of that organ are performed regularly, and that the structure of the valves is such that they are closed at the right time and can vibrate properly.

The best spot for the auscultation of the pulmonary artery is at the second left intercostal space, $\frac{1}{2}$ to 1 inch from the border of the sternum.

The sounds and murmurs of the aorta are best heard when the stethoscope is placed upon the third right costal cartilage.

For the mitral valve the position of the apex beat is the best.

For the tricuspid, the best position is at the insertion of the fourth rib into the left inferior border of the sternum.

CARDIAC MURMUR.

In some anomalies of the activity of the heart

and in anatomical changes of its valves, we hear murmurs instead of the cardiac sounds, or together with them. Not from their nature, but from the time of their appearance, and their distinctness to the ear, can conclusions be formed concerning the lesions of the heart.

Cardiac murmurs arise instead of cardiac tones, when the valves no longer form regular tones by the vibrations produced, or together with them when new formations occur in the heart, which can set the blood into audible vibrations. To their conditions therefore belongs, besides the anatomical changes, also sufficient rapidity of the current of blood. Abnormal composition of the blood in Anæmia, or Chlorosis cannot alone induce murmurs, except indirectly through its influence upon nutrition and thereby upon the tension and tonicity (power of vibration) of the valvular apparatus. Hence such murmurs arise only at the bicuspid valves, in the performance of whose functions the muscles operate.

Murmurs, therefore, generally show that the valves, from some cause or other, are no longer capable of proper tension or closure, or that upon the endocardium, within which the current of blood has a sufficient rapidity, deposits

capable of vibration have formed, especially at the ostia. Cardiac murmurs indicate insufficiency or stenosis of the valves.

In such cases the murmurs are permanent, and must be distinguished from temporary murmurs. The latter show that the functions of the papillary muscles are interfered with, from disturbance of their innervation.

Murmurs* arise with or instead of systolic sounds, synchronous with the carotid and radial pulse.

SYSTOLIC MURMURS.

According to their intensity at different points, we have drawn the following conclusions from the systolic murmurs:

(1) Systolic murmurs whose greatest intensity corresponds with the position of the apex beat, only slightly audible along the aorta, indicate either considerable mitral insufficiency, causing increase of the second pulmonary sound, or roughness upon the mitral valve.

(2) Systolic murmurs having their greatest intensity at the lower end of the sternum, as

*Gendrin distinguishes presystolic, systolic, and perisystolic and likewise pre-diastolic, diastolic and peridiastolic murmurs. Nevertheless it is important only to determine whether a murmur is systolic or diastolic.

high as the insertion of the fourth rib, indicate tricuspid insufficiency. However, the greater number of sounds heard here are occasioned by abnormal pressure of blood.

(3) Systolic murmurs at the right of the sternum, as high as the second and third ribs, denote stenosis of the aortic orifice.

(4) Systolic murmurs in the second left intercostal space, in very rare cases are occasioned by stenosis of the pulmonary orifice. They are usually the so-called anæmic murmurs.

Systolic murmurs are formed temporarily, without any organic change, in Anæmia, Chlorosis, and severe blood diseases. They are called anæmic, or better, accidental murmurs. (Bamberger.) They are never diastolic, have a weak, blowing character, and never mask the systolic sound. They are furthermore equally audible in all parts of the heart. Venous murmurs occur synchronously, which is never, or only seldom, the case in valvular defects.

With, or instead of, the second diastolic sound, we sometimes have:—

DIASTOLIC MURMURS.

(1) Diastolic murmurs having their greatest intensity at the apex beat indicate stenosis of the left venous orifice.

(2) Diastolic murmurs at the lower end of the sternum show stenosis of the right venous orifice, which is very rare.

(3) Diastolic murmurs on the right of the sternum, in the region of the 2d or 3d rib, indicate insufficiency of the aortic valves.

(4) Diastolic murmurs in the second left intercostal space indicate insufficiency of the pulmonary valves.

For the confirmation of the diagnosis of a valvular lesion, besides the facts obtained by auscultation, those not so obtained are of especial value, namely, the consequences of the single cardiac defect, which vary according to the locality of the lesion. Their determination always serves to confirm the auscultatory diagnosis, and has great value in doubtful cases. In numerous combinations of different cardiac defects, they may alone give the decision. The consequences of single cardiac defects considered by themselves are:

(1) *Mitral insufficiency*.—The blood regurgitates with each systole into the left auricle, fills this inordinately, then, as well as during the succeeding diastole of the ventricle. This afterwards produces dilatation and hypertrophy of the left heart. Then obstruction of the pul-

monic circulation with all its consequences occurs—Catarrh, Œdema and Hæmorrhagic Infarctions. As soon as the lungs become very much affected, the obstruction acts upon the right heart, which dilates and hypertrophies. Venous pulsation in the neck and increase of the systemic circulation are also observed.

The signs are: increased and extended apex beat, moderately large and usually weak pulse, uniform extension of the heart upon percussion, strengthening of the second pulmonary sound, appreciable as a diastolic beat in the second left intercostal space, systolic murmurs at the apex instead of the first sound, and venous pulsation.

(2) *Mitral stenosis*.—The left ventricle receives less blood and consequently becomes atrophied. Otherwise we have the same symptoms as in (1), only arising much more rapidly.

The apex beat is extended towards the right, is moderately strong, and not appreciable on the left side. The pulse is very weak and small. Diastolic *fremissement cataire* occurs at the nipple, and diastolic murmurs at the apex beat. The cardiac dullness has extended to the right. As a rule we have more or less systolic murmur accompanying it. The first sound in the aorta is feeble and the second in the pulmonary artery is increased.

(3) *Tricuspid Insufficiency*.—The shock is not strengthened, the pulse is unchanged, and the cardiac dullness is extended to the right. On the right we have systolic murmurs at the lower part of the sternum.

(4) *Tricuspid Stenosis*.—This seldom occurs.

(5) *Insufficiency of Aortic Valves*.—The left ventricle receives a stream of blood during diastole, simultaneously from the auricle and by regurgitation from the aorta, and thereby dilatation and hypertrophy are caused. On account of the longer resistance of the mitral valve, disturbance of both circulations takes place later.

The shock is very extensive and strong, especially to the left and upwards. There is considerable increase of the region of cardiac dullness, the arteries are dilated, and the pulse is large, hard, and twittering (*jumping pulse*). Diastolic murmurs in the left ventricle and aorta are mostly audible for some distance in the arteries.

(6) *Stenosis of the Aortic Valves*. This seldom occurs without simultaneous insufficiency. Hypertrophy of the left ventricle is produced. The shock is not strengthened, the pulse is small, and the cardiac dullness extended. Systolic murmurs occur in the ventricle

and arteries, with a feeble second sound in the aorta, on account of the slight tension of its walls.

(7) *Insufficiency*, and (8) *Stenosis* of the *pulmonary artery* rarely occur.

PERICARDIAL MURMURS.

These are produced by roughening of the pericardium, and are distinguished from endocardial murmurs by the fact that they do not occur exactly with, or much less instead of, the cardiac sounds. They are limited and may be increased by external pressure. Even when of considerable intensity they are not conducted from their point of origin. Change of position of the patient renders the murmur louder and alters its locality.

It is distinguished from the pleuritic friction sound by the fact that the latter disappears upon cessation of breathing.

If the murmurs are stronger they have the character of gentle rubbing, scraping, scratching, or crackling. The last modification may be felt by the hand, while the endocardial murmurs more closely resemble breathing or blowing.

They indicate Pericarditis, either incipient or advanced.

APEX BEAT.

This appears normally, during systole of the ventricle, at the fifth intercostal space, below and internal to the nipple.

Various opinions prevail concerning its origin.

(1) The *Lever movement* hypothesis of Kürschner is founded upon the acceptation of the fact that the heart, during systole, performs rising lever movement against the nipple, whereby the distance traversed by the apex, as the furthest point of the lever, is greatest, thus causing the impulse. This is incorrect, because the lower part of the heart lies firmly against the chest-wall and can neither leave nor approach it. If the impulse be visible in several intercostal spaces, it always appears sooner in the one above, whereas, in lever movement the reverse would take place.

(2) The *Rebounding* theory of Gutbrod and Skoda considers the action of the heart analogous to the repulsion of a gun in shooting. The rebounding of the heart, in accordance with this theory, is occasioned by the flowing of blood from the aortic orifice causing an opposite motion in the apex. We must consider that the force of repulsion is produced by the contrac-

tion of the ventricle, and the difference between the two is to be decided. According to Bamberger, the latter element preponderates, and consequently repulsion is impossible. Analogy with the evacuation of other hollow muscles, as the urinary bladder, does not allow such an admission to be made.

(3) According to Kiwsich and Bamberger the shock is caused by the systolic hardening and *arching* of the apex alone. Since the longitudinal diameter of the heart is diminished during systole, this defect must be compensated for by the systolic elongation of the larger vessels, which produces a movement to the left and downwards.

The apex beat is the safest sign of the time of systole. The following anomalies of the apex beat occur:

(a) When it appears in more than two intercostal spaces at most, and more than 2 c. m. in its greatest breadth, it proves hypertrophy of the heart.

(b) It may be weaker, as in pericardial and slight left pleuritic exudations, as long as the heart is not compressed, in union of the heart with the pericardium, in Emphysema of the left lung, and in Atrophy of the heart; or it may be

stronger and then produces shock and elevation, as in Hypertrophy with Dilatation of both ventricles.

(c) The apex beat may be changed in position. It is found at the lower portion of the sternum, at the pit of the stomach, in vertical elongation of the heart through extensive exudations, Pneumothorax, or Emphysema of the left lobe of the lungs. It is seen further to the left, and higher than normal, in horizontal position of the heart. This arises when the diaphragm is driven higher in the thoracic cavity, on the left side, as in extensive exudations into the abdomen, Tympanites, and enlargement of the left lobe of the liver. It also arises in extensive exudations into the right side of the chest, whereby the whole liver is forced to the left, and the left lobe upwards. It is found displaced to the left and downwards in hypertrophy of the left ventricle, and elongation of the ascending aorta.

Fremissement Cataire.—This consists of a feeling of light and gentle trembling, as of a purring cat, upon any point of the cardiac region. It is not similar to a palpable murmur, but like this may have a varying point and time of appearance.

Systolic *fremissement cataire* in the region of the apex beat indicates mitral insufficiency. In the

upper part of the sternum, about the third rib, it indicates stenosis of the aorta. Diastolic *fremissement cataire* at the apex beat indicates mitral stenosis, and at the upper part of the sternum, about the third rib, insufficiency of the aortic valves.

Premissement Cataire which extends over the entire cardiac region, indicates extensive lesion of several valves, abnormal communication of the cavities of the heart, or communication of an aortic aneurism, with a cavity of the heart or with a large vein.

Division of the cardiac sounds. The physical reason of this is as yet unknown. One of the cardiac sounds seems to be divided into two or three short sounds, which follow each other very rapidly. This appears most frequently in the second sound, which thereby receives the following

form : $\frac{tum}{1} \quad \frac{tr-m}{2} \quad \frac{tum}{1} \quad \frac{tr-r-rm}{2}$

Clique Metallique, is a clanging systolic sound, occurring frequently in hypertrophy. The clanging probably arises from the concussion of the thorax.

Auscultation of Blood Vessels. .

Arteries.—Under normal circumstances, when we carefully auscultate arteries without pressure,

we hear an indistinct sound corresponding with the pulse. It is only near the heart that we hear another, the conducted diastolic valvular sound.

Arterial murmurs arise through irregular vibration of the vascular walls, as the tone does through the regular, the impulse being supplied either by the gentle or more rapid current of the blood.* Arterial murmurs are recognizable by the fact, that they are intermittant and synchronous with the pulse.

It has been proved experimentally, that any constriction of the vascular walls, in whatever way produced, so that the stream passes from a narrower part of its bed into a wider one with sufficient rapidity to cause murmurs, produces them at and behind the constricted point. Roughness of the inner wall of the vessel of itself causes no murmur, but it assists their formation under the above named circumstances.

The arterial murmurs, near the heart, like the so called systolic cardiac murmurs over the arteries, indicate stenosis of the arterial orifices; at a distance from the heart they show compression of the auscultated artery, with very few ex-

*When the walls of the vessels are entirely rigid, any acoustic phenomena are impossible.

ceptions. In the latter case, they may be produced by the stethoscope in superficial arteries, by the action of muscles, as occurs in the neck in twisting the head, or by tumors, Struma, lymphatic tumors, enlarged uterus, etc.

The most important of all is the so called placental murmur, which arises by the compression of the iliac or hypogastric, seldom of the epigastric, artery by the distended uterus.

More rarely do spontaneous arterial murmurs arise through disturbance of the innervation or nutrition of the walls, which produce an irregular lumen, as in convulsive conditions, Anæmia, Typhoid Fever, and Chlorosis.

In aneurisms the occurrence of murmurs likewise depends upon the rapidity of the current of blood and the change of lumen.

Veins.—In the veins, under normal circumstances, no acoustic phenomena are produced.

Murmurs arise under the same conditions as in arteries. They presuppose an increased rapidity of the current and an inequality of lumen. They may be recognized by the fact that they are continuous, or are increased during inspiration, and often sound musical.

The veins of the neck, almost exclusively, have sufficient rapidity to render the murmurs every-

where possible; their presence, therefore, excludes obstruction of the venous circulation.

They are also usually first produced by a compression of the veins of the neck, by the stethoscope, or by twisting of the head, which permits the *bruit de diable* to be heard in almost all healthy persons. The above mentioned elements operate the easier, the more liquid the blood, and the less tonicity the venous walls possess. In this lies their relationship to Chlorosis and Anæmia.

Fœtal Pulsation.

We hear this usually in the median line between the navel and the symphysis, and refer it to the cardiac sounds of the foetus. It is heard after the sixth month of pregnancy, and is a certain sign that the child lives. Sometimes we may recognise twins through it, when the two hearts do not beat simultaneously. If, after repeated examinations in advanced pregnancy, the sound has not been heard, we may infer the death of the child.

INDEX.

	PAGE.
Ægophony	34
Amphoric resonance	34
Apex beat	46
“ “ anomalies of	47
Auscultation, method of performing	23
“ of arteries	49
“ “ blood vessels	49
“ “ circulatory organs	36
“ “ respiratory organs	23
“ “ veins	51
“ “ voice	32
Bronchial murmur	25
“ râles	30
Bronchophony	32
<i>Bruit de diable</i>	52
“ “ <i>pot fêlé</i>	14
Cardiac dullness	16
“ “ diminished	17
“ “ increased	17
“ murmurs	38
“ sounds	36
“ “ divison of	49
“ vacuum	16
<i>Clique métallique</i>	49
Cracked metal sound	14
Crepitant râles	32

INDEX.

Diastolic murmurs.....	41
“ <i>fremissement cataire</i>	49
Division of cardiac sounds.....	49
Dull sound	6
Effects of aortic insufficiency	44
“ “ “ stenosis	44
“ “ mitral insufficiency	42
“ “ “ stenosis.....	43
“ tricuspid insufficiency.....	44
Fœtal pulsation	52
<i>Fremissement cataire</i>	48
“ “ diastolic.....	49
“ “ systolic	48
Fremitus	20
Friction sounds	35
Heart, percussion of.....	15
Indefinite râles	31
“ murmur	28
Laryngeal murmur	26
Liver, percussion of	17
Lung, “ “	15
Mammary line.....	5
Metallic ringing.....	13
Murmur, arterial.....	50
“ bronchial	25
“ cardiac	38
“ diastolic	41
“ indefinite	28
“ laryngeal	26
“ pericardial	45
“ placental.....	51
“ systolic	40
“ tracheal	28
“ vesicular... ..	23

INDEX.

Non tympanitic sound.....	8
Parasternal line	5
Pectoriloquy	33
Percussion, method of performing.....	5
“ of heart	15
“ “ liver.....	17
“ “ lung	15
“ “ spleen	18
“ palpatory	19
<i>Respiration saccadée</i>	26
Râles.....	29
“ bronchial	30
“ crepitant	32
“ indefinite	31
“ vesicular.....	30
Sound, dull	6
“ friction	35
“ non tympanitic.....	7
“ sonorous.....	6
“ “ muffler of.....	12
“ tympanitic	7
Spleen, percussion of	18
Tracheal murmur.....	26
Tympanitic sound	7

